1,160,779

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,160,779

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COMPLETE SPECIFICATION

Improvements in the production of Shaped Articles from Blanks of Thermoplastics Material

We, IMPERIAL CHEMICAL INDUSTRIES LIMITED, of Imperial Chemical House, Millbank, London, S.W.1., a British Company, and A.E.W. LIMITED, of Imperial Works, High Street, Edgware, Middlesex, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to apparatus for the production of shaped thermoplastic articles and to a process of forming shaped thermoplastic articles.

According to the present invention apparatus for the production of a shaped thermoplastic article comprises feeding means arranged to feed a plurality of blanks of a thermoplastic material to an oven individually in succession for heating concurrently in the oven, and selector means in the oven arranged to select each blank individually when it has been heated to a temperature above its softening point and transfer the heated blank to an intermediate conveyor for transporting the heated blank to a mould adapted for the pressure assisted moulding of the blank into a shaped article.

Also according to another aspect of the invention a process for the production of a shaped thermoplastic article comprises feeding a plurality of blanks of a thermoplastic material individually in succession to an oven, heating the blanks concurrently in the oven, transferring each blank individually from the oven to an intermediate conveyor when it has been heated to a temperature above its softening point, and transporting the heated blank to a mould along the intermediate conveyor in which it is formed by pressure-assisted moulding into a shaped article.

In one embodiment of the invention drive means are provided, preferably in the oven, for transferring the heated blank to the intermediate conveyor.

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The selector means are included in the oven to locate a blank which has been held in the oven for a residence time long enough to heat it above its softening point and to initiate the ejection of the heated blank from the oven by the drive means. The use of such an oven construction permits individual blanks to be fed to and withdrawn from the oven in continuous succession at intervals timed to ensure that each blank is heated to a temperature at which it may be shaped by pressure-assisted moulding.

The mould may be inverted over a moulding platform to which the heated blank is transferred from the oven. With this arrangement, the mould cavity is situated above the horizontal surface of the moulding platform so that the blank is deformed upwardly into the mould cavity to produce the shaped article. This has the advantage that a shaped article produced in the mould may be withdrawn from the moulding position resting upon its peripheral unmoulded flanges to facilitate further handling of the shaped article. In this arrangement, the blank is transported in a horizontal plane throughout the whole heating and moulding process.

In an alternative arrangement, the blank may be suspended vertically and transported in a vertical plane throughout the heating and moulding process. This may be achieved by suspending the blank from an endless track. Use of this system avoids the risk of marking the surface of the blank during transportation, which would otherwise exist when the blank is transported horizontally over conveyor rollers for example. Furthermore, the clamping to the suspension means of the track may be maintained throughout the whole heating and mould operation. With this system the mould is arranged vertically, i.e. so that the blank is deformed in a substantially horizontal direction into the mould.

A plug may be provided for use in the initial stages of the moulding operation by moving the

plug into the mould cavity after the heated blank has been placed over the mould, thereby mechanically deforming the blank into the mould cavity. The final stage of the moulding operation is effected by pressure-assisted moulding, e.g. vacuum-moulding or blow moulding.

The thermoplastic material may consist of an acrylic sheet, such as polymethyl methacrylate, or a sheet of a homopolymer or copolymer of styrene or vinyl chloride.

The blanks may be fed to the oven along a horizontal feeding conveyor or an endless track from which they are suspended vertically. The conveyor or track may be mechanically, electrically or otherwise driven. The intermediate conveyor may also have suitable drive means.

The ensure that the surfaces of the blank are free from contamination which might impair the surface finish of the moulded article the blanks may be subjected to a washing stage. This may conveniently be accomplished by passing the blanks through a washing cabinet located before the heating oven. The washing cabinet may include jets directing streams of water on to the blank and also means, such as brushes, for scrubbing the surfaces of the blanks. The blanks may then be dried before passing to the oven.

After the blank has been formed into the shaped article, the article may be transported along a finishing conveyor. When the article is essentially rectangular in shape and it has been transported through the system in a horizontal plane, the finishing conveyor may be arranged with two mutually perpendicular limbs, each limb being provided with trimming cutters to trim one pair of the two pairs of mutually perpendicular flanges on the shaped article.

The machine and process of the invention are particularly suitable for the production of thermoplastic bath tubs. However, the invention may be used for the production of shaped articles other than bath tubs.

In order than the present invention may be more readily understood two preferred embodiments thereof are described by way of example and with reference to the drawings, in which:

Figure 1 is a perspective view of a machine for vacuum forming bath tubs through which blanks are transported in a horizontal plane;

Figure 2 is a vertical cross-sectional view of part of the machine shown in Figure 1; and

Figure 3 is a perspective view of a machine for vacuum forming bath tubs through which blanks are transported in a vertical plane.

The machine shown in Figure 1 consists of a lifting mechanism 10 for feeding blanks successively and individually from a stack of blanks 11 to a feeding conveyor 12 by which the blanks are fed to an oven 13. When each blank has been heated to a sufficient extent in the oven 13 it is transferred via an intermediate conveyor 14 to a moulding position 15. After removal from the mould at the moulding position 15 each moulded bath tub is transported along a finishing conveyor 16 where its edges are trimmed.

The lifted mechanism 10 comprises two soft rubber suction cups 17 connected to a vacuum line. Each blank in the stack of blanks 11 consists of a sheet of polymethyl methacrylate measuring 72 inches by 30 inches and 5/16 inch thick, and may be lifted individually by the lifting mechanism on to the feeding conveyor 12 consisting of a plurality of rotatable rollers 18 for transporting the blank to the oven 13.

The oven 13 has a pneumatically operable flap-door 20 aligned with the feeding conveyor 12 through which blanks may be fed individually from the feeding conveyor 12 into the oven. A similar pneumatically operable flap-door 21 is aligned with the intermediate conveyor 14 and may be opened to allow heated blanks to pass individually from the oven on to the intermediate conveyor 14. A framework 22 inside the oven has eight shelves positioned vertically above each other. One blank is located upon each of these shelves for heating to the desired temperature for vacuum forming. The framework is movable vertically by pneumatic means to register a vacant shelf with the feed conveyor 12 so that it may be charged with an unheated blank and also to register a shelf charged with a heated blank with the intermediate conveyor 14 for the withdrawal of the heated blank.

The oven 13 is heated by forced convection and has a maximum operating temperature of 170° C. Each blank is heated in the oven for a residence time of at least 35 minutes to soften it for vacuum moulding.

The intermediate conveyor 14 consists of rollers provided with means for rotatably driving them.

At the moulding position 15 an inverted cast aluminium mould 23 internally channelled and provided with inlet and outlet connections for water cooling is inverted over a moulding platform 24. A steel clamping ring 25 is attached to hydraulic rams 26 which are secured to the aluminium mould 23 and are extendable to clamp a heated blank between the clamping ring 25 and the moulding platform 24. The rams 26 are capable of moving the clamping ring 25 to a minimum clearance of 18 inches above the moulding platform 24 to permit removal of a moulded bath tub from the moulding position 15. Hydraulic rams 27 are likewise provided for clamping the mould 23 over the heated blank. The hydraulic rams 26 and 27 are operated by hydraulic fluid from the same hydraulic system, the correct clamping pressure being maintained on the clamping ring 25 by a relief valve between the hydraulic rams 26 and a return to the main hydraulic system. With this arrangement the clamping ring 25 is closed against or raised from the

moulding platform 24 at the same time as the mould 23 is lowered or raised. The rams are also retractable to a sufficient clearance above the moulding platform to permit withdrawal of a moulded bath tub from the moulding position 15. A fabric-covered timber plug 28 is attached to a hydraulic ram 29 by which it is movable upwardly to deform the heated blank into the mould cavity to within about 1 inch of the mould face. The mould 23 includes conventional vacuum forming means and vacuum line connections for completing the moulding of each blank. The plug is retractable to lie flush with the upper surface of the moulding platform while a heated blank is clamped into position, thereby supporting the centre of the blank. The plug 28 includes a plunger 30 for forming a recess in the moulded bath tub to be used as a waste pipe connection.

The mould 23 also has connections for low pressure air to facilitate release of the moulded bath tubs.

The finishing conveyor 16 has slitting saws 31 and 32 for trimming the edges of the moulded baths in two stages. A dust-screen (not shown) is located between the finishing conveyor and the moulding platform to prevent dust produced during trimming from damaging the surface of subsequent blanks during moulding.

In operation of the machine, a blank is lifted from the stack 11 and transferred on to the feeding conveyor 12 which transports the blank towards the oven 13. The flap-door 20 is opened pneumatically and the blank is transferred from the feeding conveyor 12 through the open flap-door 20 and on to a vacant shelf on the framework 22 which has been previously aligned with the feeding conveyor 12. The flop-door 20 is closed and the blank charged into the framework is heated for about 40 minutes. During this time the framework may be moved to bring any other shelf into alignment with the feeding conveyor 12 or the intermediate conveyor 14 for the transfer of other blanks to or from the shelf. When the heating of the blank is complete after 40 minutes the shelf upon which it is held is brought into alignment with the intermediate conveyor 14 and the heated blank transferred to the intermediate conveyor by means of the driving means associated with the shelf.

The heated blank is transported along the intermediate conveyor 14 and placed on the moulding platform 24 while the clamping ring 25 and the mould 23 are held in the raised position above the moulding platform 24. The clamping ring 25 and the mould 23 are then lowered by extending the rams 26 and 27. The clamping ring 25 is lowered slightly in advance of the mould 23 so that the heated blank is firstly clamped against the moulding platform 24 by the clamping ring 25 and then finally by the mould 23. When both the clamping ring 25 and the mould 23 are firmly clamped against the blank and the moulding platform 24 the moulding of the blank is begun by gradually moving the plug 28 upwardly under the extension of the ram 29. During this part of the moulding process the plug 28 deforms the blank into the mould cavity. The movement of the plug 28 into the mould cavity is terminated when the upper surface of the plug 28 has been raised to one inch below the facing surface of the mould cavity. To mould the blank to the exact contours of the mould cavity vacuum is applied between the surface of the mould cavity and the blank.

Finally the plunger 30 is extended to produce the recess for the waste pipe connection. The moulding is allowed to cool in the mould 23, cooling being aided by the passage of water through the mould 23.

When the moulding process is completed the mould 23 and the clamping ring 25 are raised away from the moulding platform 24, low pressure air being introduced between the surface of the mould cavity and the moulded bath tub to aid the release of the bath tub from the mould 23.

The moulded bath tub is transferred manually from the moulding platform 25 on to the finishing conveyor 16 where it is clamped to a supporting former for the trimming process. After the moulded bath tub has been removed from the moulding platform 25 a further heated blank is removed from the oven 13 and placed upon the moulding platform 25. Moulding is then carried out as described above.

In the trimming process the moulded bath tub clamped to the former is moved manually along the finishing conveyor 16, the side flanges of the bath being trimmed by the slitting saws 31. The end flanges of the moulded bath tub are then trimmed by the slitting saws 32.

A modification of the machine shown in Figures 1 and 2 includes a washing cabinet located between the stack of blanks 11 and the feeding conveyor 12. This washing cabinet is employed to remove surface contamination from the blanks 11 and includes a set of brushes arranged to scrub each surface of each blank 11 and a set of jets directing water on to the surfaces of each blank. After each blank has been subjected to this washing step and has been dried it is passed along the feeding conveyor 12 to the oven 13, thereafter being subjected to the sequence of operations described with reference to Figures 1 and 2.

Figure 3 shows an endless track 40 having suspension means 41 from each of which blanks 42 are suspended individually in a vertical plane. The track 40 passes through a loading position 43 at which blanks of polymethyl methacrylate sheet measuring 72 inches by 30 inches and 5/16 inch thick are clamped to the suspension means 41. In the direction in which the blanks are transported through the machine the track then passes through a heat-

ing oven 45 and then to a moulding position 46.

The oven 45 is heated by forced convection to a maximum operating temperature of 170° C. A pair of inspection doors 47 are provided for access to and maintenance of the oven interior. Inside the oven 45 the track loops as shown in dotted lines into a collector unit 48 having a capacity for accommodating seven blanks together. Blanks are fed into the oven 45 individually through a vertical slot door 49 provided with flexible flaps 51 to prevent heat loss. Each blank, secured to its suspension means, is fed individually on to the collector unit 48 inside the oven and is transported through the oven for a residence time of 40 minutes to soften it for vacuum moulding. Successive blanks are fed into the oven for successive transportation and heating. At the end of its traverse through the oven each blank is removed from the collector unit 48 and leaves through a vertical slot door (obscured in Figure 3) provided with flexible flaps to minimise heat losses and similar to the door 49.

The heated blank is transported after it leaves the oven along an intermediate fast traverse conveyor 54 which carries the blank rapidly to the moulding position 46 to avoid excessive heat losses. The heated blank is suspended from the suspension means from the track 40 while it is in the moulding position 46, there being no necessity to release the blank from its suspension means.

At the moulding position a cast aluminium mould 56 is arranged vertically on one side of the blank while on the other side an assembly 57 comprising a plug, clamping ring and associated components are movable hydraulically under the activation of hydraulic rams in a substantially horizontal direction toward the mould 56. The assembly 57 moves along carriers 58. The mould 56 and assembly 57 are shown in Figure 3 for convenience in a schematic fashion only; they are substantially the same in construction and operation as the like units and their associated components shown in Figures 1 and 2. The constructional details are particularly apparent from the description of Figure 2. However, this embodiment differs from that shown in Figures 1 and 2 in that the plug and clamping ring move in a substantially horizontal direction toward the mould and also that the blank is deformed in a substantially horizontal direction during vacuum moulding of the blank after it has been initially shaped by the plug. The reader is referred to the description of Figures 1 and 2 for a full understanding of the construction and operation of the mould 56 and the assembly 57.

After the moulding process, which is concluded with the production of a recess for a waste pipe connection by means of a plunger similar to the plunger 30 shown in Figure 2, the moulding is allowed to cool before the mould is opened. When the moulding is cool enough to allow it to be handled without risk of impairing its shaping, the mould is opened and the moulding removed on the suspension means at a slow traverse speed to a position 60 where the moulding may be removed from the suspension means, after which it is subjected to a trimming process to remove the edges of the blank which were clamped under the clamping ring. The suspension means may then be circulated to the beginning of the track 40 for loading with a fresh blank of polymethyl methacrylate sheet.

A modification of the machine shown in Figure 3 includes a washing cabinet through which the blanks are passed before entering the oven 45. This is included in the machine to remove any surface contamination on the blanks which may impair the surface finish of the moulded bath tubs. The cabinet includes jets directing water on to both surfaces of the blanks and brushes for scrubbing the surfaces. The track 40 runs through the cabinet so that after loading the blank on to the suspension means 41 the blank is first washed in the cabinet and is then passed after drying to the heating oven 45.

WHAT WE CLAIM IS:—

1. A process for the production of a shaped thermoplastic article which comprises feeding a plurality of blanks of a thermoplastic material individually in succession to an oven, heating the blanks concurrently in the oven, transferring each blank individually from the oven to an intermediate conveyor when it has been heated to a temperature above its softening point, and transporting the heated blank along the intermediate conveyor to a mould in which it is formed by pressure-assisted moulding into a shaped article.

2. A process according to claim 1, which comprises heating the blanks in the oven to a temperature above the softening point of the thermoplastic material, transferring each heated blank from the oven to an intermediate conveyor by means of drive means provided in the oven, said intermediate conveyor transporting the heated blank to a mould in which the heated blank is formed by pressure-assisted moulding into a shaped article.

3. A process according to claim 2, in which the blank comprises polymethyl methacrylate sheet.

4. A process according to claim 2 or 3, in which the oven may be heated to a maximum operating temperature of 170° C.

5. A process according to claim 2, 3 or 4, in which the blank is heated for at least 35 minutes in the oven.

6. A process according to any of claims 2 to 5, in which the heated blank is firstly clamped in position in front of the mould before forming.

7. A process according to claim 6, in which the heated blank is also clamped in position by the mould.

8. A process according to any of claims 2 to 7, in which the heated blank is initially shaped by pressing a plug against the blank.

9. A process according to claim 8, in which the shaping is continued by pressure-assisted moulding.

10. A process according to claim 9, in which the shaping is continued by vacuum moulding by evacuating the space between the blank and the mould.

11. A process according to any of claims 2 to 10, in which a plunger is pressed into the blank to form a recess for a waste pipe connection when the shaped article is a bath tub.

12. A process according to any of claims 2 to 11, in which the moulded blank is allowed or caused to cool before removal from the mould.

13. A process according to claim 12, in which low pressure air is introduced between the surface of the mould and the moulded blank to aid its release from the mould.

14. A process according to any of claims 2 to 13, in which the moulded blank is trimmed after removal from the mould.

15. A process according to any of claims 2 to 14, in which the blank is transported through the heating and moulding stages in a horizontal plane.

16. A process according to claim 15, in which the blank is transported on roller conveyors.

17. A process according to any of claims 2 to 16, in which the surfaces of the blank are washed before heating in the oven.

18. A process according to any of claims 1 to 14, in which the blank is transported through the heating and moulding stages in a vertical plane.

19. A process according to claim 18, in which the blank is transported on an endless track.

20. A process according to claim 18 or 19, in which the blank is carried on suspension means mounted on the track and is not released from the suspension means until after the moulded blank has been removed from the mould.

21. A process according to claim 18, 19 or 20, in which the surfaces of the blank are washed before heating in the oven.

22. A process according to any of claims 2 to 16, in which the shaped article produced is a bath tub.

23. A process according to any of claims 1 or 17 to 21, in which the shaped article produced is a bath tub.

24. A process for the production of a shaped thermoplastic article, substantially as hereinbefore described with reference to Figures 1 and 2 of the drawings.

25. A process for the production of a shaped thermoplastic article, substantially as hereinbefore described with reference to Figure 3 of the drawings.

26. A shaped thermoplastic article when produced by a process according to any of claims 2 to 16, 22 or 24.

27. A shaped thermoplastic article when produced by a process according to any of claims 1, 17 to 21, 23 or 25.

28. Apparatus for the production of a shaped thermoplastic article which comprises feeding means arranged to feed a plurality of blanks of a thermoplastic material to an oven individually in succession for heating concurrently in the oven, and selector means in the oven arranged to select each blank individually when it has been heated to a temperature above its softening point and transfer the heated blank to an intermediate conveyor for transporting the heated blank to a mould adapted for the pressure assisted moulding of the blank into a shaped article.

29. Apparatus according to claim 28, which comprises an oven for heating each of the blanks to a temperature above the softening point of the thermoplastic material and having drive means for transferring the heated blank to an intermediate conveyor for transporting the heated blank to a mould adapted for the pressure assisted moulding of the blank into a shaped article.

30. Apparatus according to claim 29, in which the oven may be heated to a maximum operating temperature of 170° C.

31. Apparatus according to claims 29 or 30, having clamping means for clamping the heated blank in front of the mould before forming.

32. Apparatus according to claim 31, in which the mould is also adapted to clamp the heated blank in position.

33. Apparatus according to any of claims 29 to 32, which includes a plug which may be pressed against the heated blank to initially shape the blank.

34. Apparatus according to claim 33, which is arranged to continue the shaping by pressure-assisted moulding.

35. Apparatus according to claim 34, which is arranged to continue the shaping by the evacuation of the space between the blank and the mould.

36. Apparatus according to any of claims 29 to 35, which includes a plunger for pressing into the blank to form a recess for a waste pipe connection when the shaped article is a bath tub.

37. Apparatus according to any of claims 29 to 36, which includes means for introducing low pressure air between the surface of the mould and the moulded blank to aid its release from the mould.

38. Apparatus according to any of claims 29 to 37, which includes means for trimming the moulded blank after removal from the mould.

39. Apparatus according to any of claims 29 to 38, which is arranged to transport the blank through the heating and moulding stages in a horizontal plane.

40. Apparatus according to claim 39, which includes roller conveyors for the transportation of the blank.

41. Apparatus according to any of claims 29 to 40, in which a washing cabinet is located prior to the oven.

42. Apparatus according to any of claims 28 to 44, which is arranged to transport the blank through the heating and moulding stages in a vertical plane.

43. Apparatus according to claim 42, which includes an endless track for the transportation of the blank.

44. Apparatus according to claim 43, in which suspension means are mounted on the track for carrying the blank.

45. Apparatus according to claim 44, in which the suspension means are adapted to carry the blank through the whole heating and moulding operation.

46. Apparatus according to any of claims 42 to 45, in which a washing cabinet is located prior to the oven.

47. Apparatus according to any of claims 29 to 40, which is adapted to produce a bath tub.

48. Apparatus according to any of claims 28 or 41 to 46, which is adapted to produce a bath tub.

49. Apparatus for the production of a shaped article, substantially as hereinbefore described with reference to Figures 1 and 2 of the drawings.

50. Apparatus for the production of a shaped thermoplastic article, substantially as hereinbefore described with reference to Figure 3 of the drawings.

51. A shaped thermoplastic article when produced by an apparatus according to any of claims 29 to 40, 47 or 49.

52. A shaped thermoplastic article when produced by an apparatus according to any of claims 28, 41 to 46, 48 or 50.

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Agent for the Applicants.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

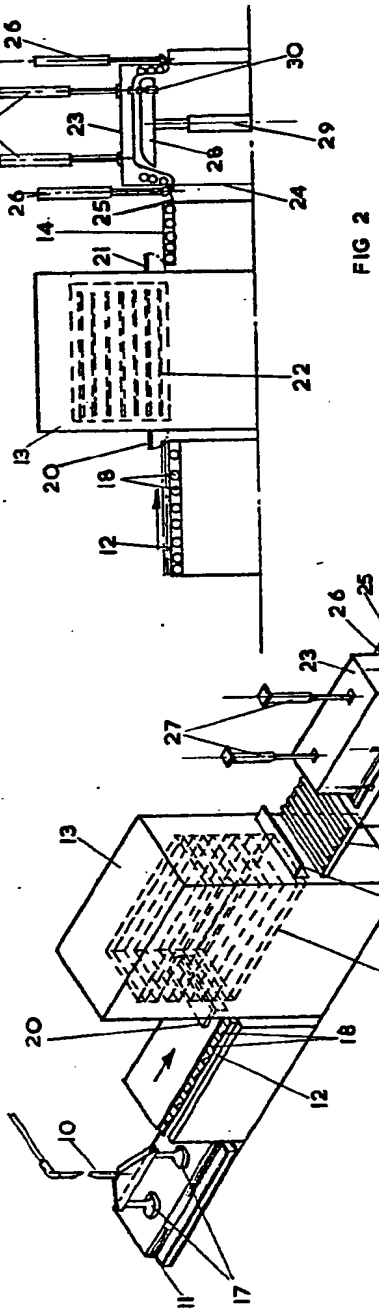

FIG 2

FIG 1

1160779 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

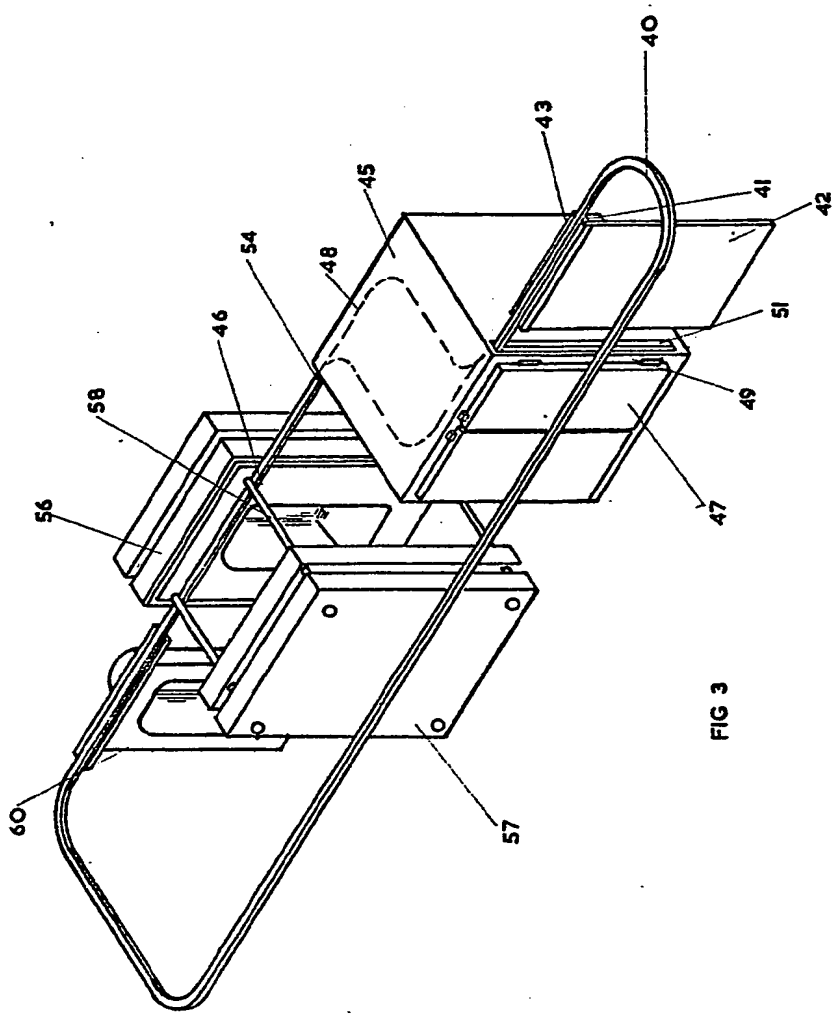

FIG 3